Amendments to the Claims

This list of claims will replace all prior versions, and listings, of claims in the application.

1. (Currently amended) A method for assessing brain state by analysing mammalian brain electroencephalogram (EEG) recordings using an eighth order autoregressive and fifth order moving average discrete time equation, further including the steps of taking a z-transform for said eighth order autoregressive and fifth order moving average discrete time equation to obtain a z-domain equation, determining poles and zeroes in the solution of the z-domain equation; and plotting the poles onto the complex plane and displaying positions of the poles.

2. (Cancelled)

3. (Currently amended) A method of assessing the state of a mammalian brain including the steps of:

(i) obtaining an electroencephalogram (EEG) from the brain;

(ii) digitising the EEG to define a digitised EEG data signal;

(iii) segmenting the EEG data signal into time frames of fixed length, y[n];

(iv) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(v) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(vi) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z) = \frac{\sum_{k=0}^{5} b_k z^{-k}}{1+\sum_{k=1}^{8} a_k z^{-k}} U(z) = \frac{B(z)}{A(z)} U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$$

$$B(z) = \sum_{k=0}^{5} b_k z^{-k}$$

(vii) substituting each of the values of the coefficients into the z-domain equation;

(viii) solving A(z) = 0 for z in the second equation to determine the poles;

(ix) ~~plotting~~ determining the positions of the poles in the complex plane;

(x) repeating steps (iv) to (ix) for each frame in the sample to determine clusters of poles in the complex plane; and

(xi) ~~assessing the state of the brain by reference to~~displaying the position and distribution of at least some of said clusters of poles ~~as mapped~~ in the complex plane.

4. (Currently amended) A method of assessing the ~~state of~~ efficacy of an intervention in a mammalian brain including the steps of:

(i) obtaining an electroencephalogram (EEG) from the brain;

(ii) digitising the EEG to define a digitised EEG data signal;

(iii) segmenting the EEG data signal into time frames of fixed length, y[n];

(iv) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(v) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(vi) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z) = \frac{\sum_{k=0}^{5} b_k z^{-k}}{1 + \sum_{k=1}^{8} a_k z^{-k}} U(z) = \frac{B(z)}{A(z)} U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$$

$$B(z) = \sum_{k=0}^{5} b_k z^{-k}$$

(vii) substituting each of the values of the coefficients into the z-domain equation;

(viii) solving A(z) = 0 for z in the second equation to determine the poles;

(ix) ~~plotting~~determining the positions of the poles in the complex plane;

(x) repeating steps (iv) to (ix) for each frame in the sample to determine first clusters of poles in the complex plane; and

(xi) administering an intervention to the brain;

(xii) repeating steps (i) to (x) at least once in order to obtain second clusters of poles in the complex plane;

(xiii) ~~monitoring movement of at least some of said clusters of poles in the complex plane;~~displaying the positions of at least some of the first and second clusters of poles; and

(xiv) assessing the~~ state of the brain~~ efficacy of the intervention by reference to movement of at least some of said first and second clusters of said displayed poles~~ as mapped~~ in the complex plane.

5. (Previously presented) A method as claimed in claim 3 including the step of filtering the EEG to remove noise signals therefrom prior to carrying out step (iii).

6. (Previously presented) A method as claimed in claim 3, wherein said EEG is obtained and recorded before it is processed.

7. (Currently amended) A method of assessing the state of a mammalian brain including the steps of:

(i) obtaining a first electroencephalogram (EEG) from the brain;

(ii) digitising the EEG to define a digitised EEG data signal;

(iii) segmenting the EEG data signal into time frames of fixed length, y[n];

(iv) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(v) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(vi) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z) = \frac{\sum_{k=0}^{5} b_k z^{-k}}{1 + \sum_{k=1}^{8} a_k z^{-k}} U(z) = \frac{B(z)}{A(z)} U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$

$B(z) = \sum_{k=0}^{5} b_k z^{-k}$

(vii) substituting each of the values of the coefficients into the z-domain equation;

(viii) solving A(z) = 0 for z in the second equation to determine the poles;

(ix) ~~plotting~~determining positions of the poles in the complex plane;

(x) repeating steps (iv) to (ix) for each frame in the sample to determine clusters of poles in the complex plane;

(xi) obtaining a second EEG from said brain at a later time;

(xii) repeating steps (ii) to ~~(x)~~ (xi) in relation to the second EEG at least once;

(xiii) ~~monitoring the movement of at least some corresponding clusters of poles in the complex plane derived from the first and second EEGs respectively;~~displaying the positions of at least some of the poles derived from the first and second EEGs respectively in the complex plane; and

(xiv) assessing the state of the brain by reference to movement of at least some of said clusters of ~~displayed~~ poles ~~as mapped in the complex plane~~.

8. (Original) A method as claimed in claim 6 including the step of filtering the EEG to remove noise signals therefrom prior to carrying out step (iii).

9. (Previously presented) A method as claimed in claim 7, wherein said first and second EEG is obtained and recorded before it is processed.

10. (Previously presented) A method as claimed in claim 7, wherein said EEG, or said first and second EEG, is obtained and recorded in its entirety for processing at a later point in time.

11. (Previously presented) A method as claimed in claim 7, wherein said EEG, or said first and second EEG, is each repeatedly obtained over consecutive and constant time intervals.

12. (Original) A method as claimed in claim 11, wherein a said time interval may overlap with an immediately preceding time interval.

13. (Previously presented) A method as claimed in claim 3, wherein the step of step (x) is repeated continuously to track the motion of the poles from each segment.

14. (Previously presented) A method as claimed in claim 3, wherein the step of step (xi) includes the steps:

(xi)(a) taking the centroid of the poles for each cluster of poles; and

(xi)(b) monitoring and comparing the movement of said centroids.

15. (Original) A method as claimed in claim 14 including the step of:
(xi)(c) analysing the statistical variability of the poles in said clusters of poles.

16. (Currently amended) A method as claimed in claim 7, wherein the step of step ~~(xiv)~~ (xv) includes the steps of:

~~(xiv)~~(xv)(a) taking the centroid of the poles for each cluster of poles; and

~~(xiv)~~(xv)(b) monitoring and comparing the movement of said centroids.

17. (Currently amended) A method as claimed in claim 16 including the step of:
~~(xiv)~~(xv)(c) analysing the statistical variability of the poles in said clusters of poles.

18.-23. (Cancelled)

24. (Currently amended) The method as claimed in claim 1 further comprising a ~~A~~ system having means for analysing mammalian brain electroencephalogram (EEG) recordings using an eighth order autoregressive and fifth order moving average discrete time equation ~~performing the method as claimed in claim 1~~.

25. (Cancelled)

26. (Currently amended) ~~A~~ The method as claimed in claim 3 wherein steps (i) – (xi) are performed by a computer having a computer readable medium ~~having~~ with computer program instructions stored thereon ~~which, when executed by a computer, performs the steps in the method as claimed in claim 3~~.

27. (New) A method as claimed in claim 3 wherein step (xi) is used to assess the state of vigilance or alertness of a subject.

28. (New) A method as claimed in claim 3 wherein step (xi) is used to assess the state of sleep of a subject.

29. (New) A method as claimed in claim 3 wherein step (xi) is used to assess the state of anaesthesia of a subject.

30. (New) A system for displaying the activity of a mammalian brain, the system including:

a plurality of electrodes for picking up EEG signals from the brain;

digitising means for converting the EEG signals to a digitised EEG data signal;

computing means for:

(i) segmenting the EEG data signal into time frames of fixed length, y[n];

(ii) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(iii) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(iv) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z) = \frac{\sum_{k=0}^{5} b_k z^{-k}}{1 + \sum_{k=1}^{8} a_k z^{-k}} U(z) = \frac{B(z)}{A(z)} U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$$

$$B(z) = \sum_{k=0}^{5} b_k z^{-k}$$

(v) substituting each of the values of the coefficients into the z-domain equation;

(vi) solving A(z) = 0 for z in the second equation to determine the poles;

(vii) determining the positions of the poles in the complex plane;

(viii) repeating steps (ii) to (vii) for each frame in the sample to determine clusters of poles in the complex plane; and

display means for displaying the position and distribution of at least some of said clusters of poles in the complex plane.

31. (New) A system for assessing the efficacy of an intervention in a mammalian brain, the system including:

a plurality of electrodes for picking up EEG signals from the brain;

digitising means for converting the EEG signals to a digitised EEG data signal;

computing means for:

(i) segmenting the EEG data signal into time frames of fixed length, y[n];

(ii) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(iii) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(iv) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z) = \frac{\sum_{k=0}^{5} b_k z^{-k}}{1 + \sum_{k=1}^{8} a_k z^{-k}} U(z) = \frac{B(z)}{A(z)} U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$$

$$B(z) = \sum_{k=0}^{5} b_k z^{-k}$$

(v) substituting each of the values of the coefficients into the z-domain equation;

(vi) solving A(z) = 0 for z in the second equation to determine the poles;

(vii) determining the positions of the poles in the complex plane;

(viii) repeating steps (ii) to (vii) for each frame in the sample to determine first clusters of poles in the complex plane and, after administration of an intervention to the brain;

(ix) repeating steps (i) to (vii) at least once in order to obtain second clusters of poles in the complex plane; and

display means for displaying the position and distribution of at least some of said first and second clusters of poles in the complex plane in order to assess the efficacy of the intervention.

32. (New) A system for displaying the activity of a mammalian brain, the system including:

a plurality of electrodes for picking up EEG signals from the brain;

digitising means for converting the EEG signals to a digitised EEG data signal;

computing means for:

(i) segmenting the EEG data signal into time frames of fixed length, y[n];

(ii) approximating each digitised time frame by a first equation:

$$y[n] = -\sum_{k=1}^{8} a_k y[n-k] + \sum_{k=0}^{5} b_k u[n-k]$$

where a_k and b_k are coefficients to be determined for the EEG data signal, $y[n]$ represents the digitized EEG data signal, and $u[n]$ represents a Gaussian white noise process;

(iii) solving the first equation to determine coefficients a_1 to a_8 and b_0 to b_5;

(iv) performing a z-transform on the first equation to obtain a second, z-domain equation:

$$Y(z)=\frac{\sum_{k=0}^{5} b_k z^{-k}}{1+\sum_{k=1}^{8} a_k z^{-k}}U(z)=\frac{B(z)}{A(z)}U(z)$$

where

Y[z] represents y[u] in the z-domain and U(z) represents u[n] in the z-domain, and:

$$A(z) = 1 + \sum_{k=1}^{8} a_k z^{-k}$$

$$B(z) = \sum_{k=0}^{5} b_k z^{-k}$$

(v) substituting each of the values of the coefficients into the z-domain equation;

(vi) solving A(z) = 0 for z in the second equation to determine the poles;

(vii) determining positions of the poles in the complex plane;

(viii) repeating steps (ii) to (vii) for each frame in the sample to determine clusters of poles in the complex plane;

(ix) obtaining a second EEG from said brain at a later time; and

(x) repeating steps (i) to (viii) in relation to the second EEG at least once; and

display means for displaying the position and distribution of at least some of said clusters of poles in the complex plane derived from the first and second EEGs.